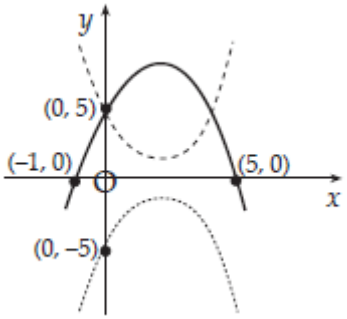
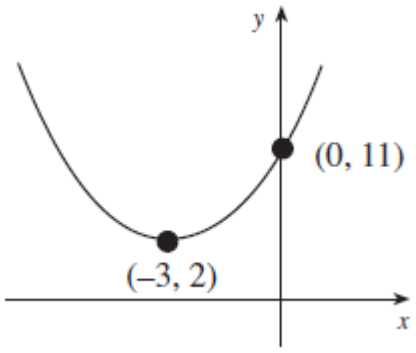
01 P1 Q2	**3C** •1 $b^2-4ac=0$ stated •2 $(-5)^2-4\times(k+6)$ •3 $k=\frac{1}{4}$
01 P1 Q4	**2C** •1 $(x+1)^2$ ..... •2 $(x+1)^2-9$
01 P2 Q11	**3A, 3A** •1 $y=k(x+1)(x-p)$ •2 $k=-1$ with justification ie substitute $(0,p)$ •3 $y=-1(x+1)(x-p)$ & *complete* •4 $x^2+2x-px=0$ •5 $b^2-4ac=(2-p)^2=0$ *OR* $(2-p)^2-4\times0=0$ •6 $p=2$ **OR** •4 $(0,p)$ common point *and* $m_{line}=1$ •5 $\frac{dy}{dx}=(p-1)-2x$ *and* $m_{tgt(0,p)}=p-1$ •6 $p=2$
02 P1 Q7	**2C, 4C, 1B** •1 $a=2$ •2 $b=1$ •3 *any 2 from* parabola; min tp(2,1); (0,5) •4 the remaining one from above list •5 reflecting in $x-$axis •6 translating $+10$units $\parallel^{el}$ to $y-$axis •7 $(-1,5)$ *ie* $-1<x<5$ 
02 P2 Q9	**5B** •1 discriminant = ... •2 disc $=(-5k)^2-4(1-2k)(-2k)$ •3 $9k^2+8k$ •4 e.g. draw a table, graph complete the square •5 complete proof and conclusion relating to disc. ≥ 0
03 P1 Q2	**2C, 2C** •1 $(x+3)^2$ •2 $+2$ **(a)** ans: $(x+3)^2+2$

	•3 *any two from* * *cup – shaped parabola* * *minimum at* $(-3,2)$ * *intercept on* $y-$*axis at* $(0,11)$ •4 *all three of the above facts* 
03 P1 Q7	**5B** •1 $x^2+3x+4=2x+1$ •2 $x^2+x+3=0$ the zero explicitly stated •3 $b^2-4ac=1^2$ ..... •4 $b^2-4ac=-11$ •5 $b^2-4ac<0$ ∴ no intersection •3 $\left(x+\frac{1}{2}\right)^2+\frac{11}{4}$ •4 *so* x^2+x+3 *is cup,* min *at* $\left(-\frac{1}{2},\frac{11}{4}\right)$ •3 $\frac{dy}{dx}=2x+1=0\Rightarrow x=-\frac{1}{2},\ y=\frac{11}{4}$ •4 *so* x^2+x+3 *is cup,* min *at* $\left(-\frac{1}{2},\frac{11}{4}\right)$
04 P2 Q3	**2C, 2B** •1 *know to show* $b^2-4ac\geq 0$ •2 $p^2-4\times 2\times(-3)$ •3 p^2+24 •4 p^2 *is positive* *so* $\Delta\geq 0$ *and roots real*
06 P1 Q8	**3B, 1C** •1 $a=2$ •1 $2(x^2+2x)$ •1 $2x^2+4x-3=ax^2+2abx+ab^2+c$ $\Rightarrow a=2$ •2 $b=1$ •2 $2(x+1)^2$ •2 $2ab=4$ $\Rightarrow b=1$ •3 $c=-5$ •3 $2(x+1)^2-5$ •3 $ab^2+c=-3$ $\Rightarrow c=-5$ •4 $(-1,-5)$
06 P2 Q2	**4C** •1 $"b^2-4ac"=0$ •2 $a=k, b=k, c=6$ •3 $k(k-24)$ •4 $k=0$ *and* $k=24$ ∴ $k=24$ **OR** •4 $k\neq 0$ *or* 24 **Notes**

	$\surd \bullet^1, \surd \bullet^2 \quad k^2 - 4 \times k \times 6 = 0$ $\surd \bullet^3 \quad k(k-24)$ *or* $\surd \bullet^2 \quad k^2 - 4 \times k \times 6$ $\surd \bullet^1, \surd \bullet^3 \quad k(k-24) = 0$
06 P2 Q3	**4C, 5C** $\bullet^1 \quad \frac{dy}{dx} =$ $\bullet^2 \quad 2x - 14$ $\bullet^3 \quad m = 2$ **stated or implied by •4** $\bullet^4 \quad y - 5 = 2(x-8)$ $\bullet^5 \quad y = 2x - 11$ $\bullet^6 \quad 2x - 11 = -x^2 + 10x - 27$ $\bullet^7 \quad x^2 - 8x + 16 = 0$ $\bullet^8 \quad (x-4)^2 = 0 \Rightarrow$ *equal roots so tgt* $\bullet^9 \quad Q = (4, -3)$ **Notes** $\bullet^8 \quad b^2 - 4ac = 64 - 4 \times 16 = 0 \Rightarrow$ *line is a tangent* $\bullet^5 \quad 2x = y + 11$ $\bullet^6 \quad 4y = -(y^2 + 22y + 121) + 20y + 220 - 108$ $\bullet^7 \quad y^2 + 6x + 9 = 0$ $\bullet^8 \quad (y+3)^2 = 0 \Rightarrow$ *equal roots so tgt* $\bullet^9 \quad Q = (4, -3)$ $\bullet^5$ *Find the equ. of the tgt to 2nd curve with grad. 2* **stated or implied by •6** $\bullet^6 \quad -2x + 10 = 2$ $\bullet^7 \quad Q = (4, -3)$ $\bullet^8 \quad y - (-3) = 2(x-4)$ $\bullet^9 \quad y = 2x - 11$ *which is the same equ. as* (a) **stated explicitly**
07 P1 Q4	**4C** $\bullet^1 \quad b^2 - 4ac < 0$ $\bullet^2 \quad a = k,\ b = -1,\ c = -1$ $\bullet^3 \quad 1 + 4k$ $\bullet^4 \quad k < -\frac{1}{4}$

12 P2 Q1	start composite process correct substitution into expression complete second composite obtain a quadratic expression know to and use discriminant interpret result	•1 e.g. $f(x+4)$ **stated, or implied** •2 $(x+4)^2+3$ •3 x^2+3+4 •4 $2x^2+8x+26$ •5 $8^2-4\times2\times26$ or $4^2-4\times1\times13$ **stated,** •6 $-144<0$ or $-36<0$ so no real roots
13 P1 Q21	identify common factor complete the square process for c	**Method 1** •1 $2(x^2+6x\ldots$ **stated or implied by** •2 •2 $2(x+3)^2$ .... •3 $2(x+3)^2-17$
	expands completed square form equates coefficients process for b and c and write in required form	**Method 2** •1 $ax^2+2abx+ab^2+c$ •2 $a=2\quad 2ab=12\quad ab^2+c=1$ •3 $2(x+3)^2-17$
14 P2 Q3	interpret notation a correct expression	•1 $f(x+3)$ stated or implied by •2 •2 $=(x+3)(x+2)+q$ **OR** $=(x+3)^2-(x+3)+q$ or equivalent
	write in standard quadratic form	•3 $x^2+5x+6+q=0$
	use discriminant	•4 $b^2-4ac=5^2-4\times1\times(6+q)$
	simplify and equate to zero	•5 $\Rightarrow 25-24-4q=0$
	find value of q	•6 $q=\frac{1}{4}$

ANSWERS **Pre 2000 – Completing the Square**

1	•1 $a=4$ •2 $b=2$ •3 $(-4,2)$	
2	•1 $4x^2+8x-5$ •2 $4(x+1)^2$ •3 $c=-9$	Strategy: expand $a(x+b)^2+c$ and compare coefficients •1 $4x^2+8x-5$ •2 $a=4$ ***and*** $b=1$ •3 $c=-9$

3	$\bullet^1$ $a=2$ $\bullet^2$ $b=2$ $\bullet^3$ $c=-11$ $\bullet^4$ $(-2,11)$
4	$\bullet^1$ $2(x^2-2x)+5$ *stated or implied by* $\bullet^3$ $\bullet^2$ $2(x-1)^2+\ldots\ldots$ *stated or implied by* $\bullet^3$ $\bullet^3$ $2(x-1)^2+3$ $\bullet^4$ stationary pt at $(1,3)$ $\bullet^5$ stationary pt is minimum
5	$\bullet^1$ $a=8$ $\bullet^2$ $b=1$ $\bullet^3$ $\max=8$ $\bullet^4$ $(x+1)^2\geq 0$, smallest value is zero
6	$\bullet^1$ $a=3$ $\bullet^2$ $b=2$ $\bullet^3$ $\min\left(x^2+6x+11\right)=2$ $\bullet^4$ $\max\left(\frac{1}{x^2+6x+11}\right)=\frac{1}{2}$

ANSWERS **Pre 2000 - Using the Discriminant**

1	$\bullet^1$ $b^2-4ac=0$ $\bullet^2$ $x^2+6x+9=0$ $\bullet^3$ $b^2-4ac=36-36=0$ *OR* $\bullet^3$ $(x+3)(x+3)=0$ so roots are $-3,\ -3$
2	$\bullet^1$ $b^2-4ac=0$ $\bullet^2$ $a=2\frac{1}{2}$
3	$\bullet^1$ $x^2+kx-x+4-k=0$ $\bullet^2$ $b^2-4ac=0$ $\bullet^3$ $(k-1)^2-4(4-k)$ $\bullet^4$ $k^2+2k-15=0$ $\bullet^5$ $k=-5,\ k=3$
4	$\bullet^1$ discriminant $=16-4\times 2\times k$ $\bullet^2$ $16-8k\geq 0$ for real roots $\Rightarrow k\leq 2$
5	$\bullet^1$ *strat*: use discriminant $\bullet^2$ $b^2-4ac<0$ $\bullet^3$ $64-4k^2$ $\bullet^4$ $k=5$

6	$\bullet^1$	for realising "$b^2-4ac"\geq 0$			
	$\bullet^2$	$kx^2+3x+(3-k)=0$			
	$\bullet^3$	$\Delta=3^2-4k(3-k)$			
	$\bullet^4$	$\Delta=(2k-3)^2$			
	$\bullet^5$	for stating $(2k-3)^2$ is ≥ 0 for all real k			
7	$\bullet^1$	*use* discriminant Δ			
	$\bullet^2$	$\Delta=(3k-2)^2-8k(k-2)$			
	$\bullet^3$	$\Delta=k^2+4k+4$			
	$\bullet^4$	$(k+2)^2\geq 0$ so roots real			
8	$\bullet^1$	$\frac{dy}{dx}=\ldots\ldots$	OR	$\bullet^1$	$\frac{dy}{dx}=\ldots\ldots$
	$\bullet^2$	$6x^2+6x+4$		$\bullet^2$	$6x^2+6x+4$
	$\bullet^3$	*e.g.* "$b^2-4ac"=\ldots\ldots$		$\bullet^3$	*e.g.* complete square……
	$\bullet^4$	-60 *or* -15 (from $3x^2+3x+2$)		$\bullet^4$	$S=6\left(x+\frac{1}{2}\right)^2+2\frac{1}{2}$
	$\bullet^5$	Δ negative so no st. points		$\bullet^5$	$S\geq 2\frac{1}{2}$ so no st. points

ANSWERS **Pre 2000 - Extended Questions**

1	(*a*)	$\bullet^1$	$4x-x^2=0$ *stated or implied by* $\bullet^2$
		$\bullet^2$	$(4,0)$
	(*b*)	$\bullet^3$	$m=-\frac{1}{2}$
		$\bullet^4$	$y=-\frac{1}{2}x+2$ *or* $y-2=-\frac{1}{2}(x-0)$ *or* $y-0=-\frac{1}{2}(x-4)$
	(*c*)	$\bullet^5$	$4x-x^2=2-\frac{1}{2}x$
		$\bullet^6$	*e.g.* $2x^2-9x+4=0$
		$\bullet^7$	$x=\frac{1}{2}, x=4$
		$\bullet^8$	Q is $\left(\frac{1}{2},\frac{7}{4}\right)$
2	(*a*)	$\bullet^1$	inverted shape
		$\bullet^2$	passing through origin
		$\bullet^3$	annotating $(1,2)$
		$\bullet^4$	annotating $(2,0)$
	(*b*)	$\bullet^5$	endpoints of $0\leq x\leq 2$
		$\bullet^6$	"less than signs" of $0\leq x\leq 2$
	(*c*)	$\bullet^7$	$g(x)=ax(x-2)$
		$\bullet^8$	$(1,2)\Rightarrow 2=a(1-2)$
		$\bullet^9$	$g(x)=-2x(x-2)$

3

(a)

- $\bullet^1$ $g(2x+1)$
- $\bullet^2$ $(2x+1)^2+k$
- $\bullet^3$ $f\left(x^2+k\right)$
- $\bullet^4$ $2\left(x^2+k\right)+1$

(b)

- $\bullet^5$ $4x^2+4x+k+1$ *AND* $2x^2+2k+1$
- $\bullet^6$ $4x^2+4x+k+1-\left(2x^2+2k+1\right)=0$

  so $2x^2+4x-k=0$
- $\bullet^7$ $b^2-4ac=16-4\times2\times(-6)=64$
- $\bullet^8$ so roots real & distinct
- $\bullet^9$ $b^2-4ac=16-4\times2\times(-k)$
- $\bullet^{10}$ $b^2-4ac=0$ for equal roots
- $\bullet^{11}$ $k=-2$

4

(a)

- $\bullet^1$ $2p+q=-2$

(b)

- $\bullet^2$ strategy
- $\bullet^3$ $2x+p$
- $\bullet^4$ gradient = 1, or equivalent
- $\bullet^5$ $4+p$
- $\bullet^6$ $p=-3$
- $\bullet^7$ $q=4$

(c)

- $\bullet^8$ $\Delta=-7$
- $\bullet^9$ $\sqrt{-7}$ means no roots

5

(a)

- $\bullet^1$ $y=ax^2+bx+c$
- $\bullet^2$ $(0,40)\Rightarrow c=40$
- $\bullet^3$ symmetry $\Rightarrow b=0$
- $\bullet^4$ $(20,0)\Rightarrow a=-\frac{1}{10}$

(b)

- $\bullet^5$ strategy: find equ of line and solve with parabola
- $\bullet^6$ *e.g.* gradient of left line = 2
- $\bullet^7$ $y=2x+50$
- $\bullet^8$ $2x+50=40-\frac{1}{10}x^2$
- $\bullet^9$ $x^2+20x+100=0$
- $\bullet^{10}$ $b^2-4ac=0$ *or* $(x-10)^2=0$
- $\bullet^{11}$ equal roots so line is tangent to parabola